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RESULTS FROM A DECADE OF BLACK-TAILED PRAIRIE DOG MONITORING

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Abstract: The black-tailed prairie dog (*Cynomys ludovicianus*), a keystone prairie species, historically occupied over 404,700 ha (100 million ac) of short- and mixed-grass prairie. Today, they occupy less than 2% of their original range. Scotts Bluff National Monument, Nebraska is one of eight National Park Service units with one or more black-tailed prairie dog colonies. Since 1995, a total of 202 observations were made on the population of the main colony at Scotts Bluff National Monument, to estimate annual densities and abundances. Estimated annual densities ranged between 9.2 and 53.0 individuals/ha (2.5 ac). Average density of prairies dogs was 25.1 individuals/ha (2.5 ac) annually. With the exception of 1996 and 2005 (density estimates 53.0 and 44.9 individuals/ha (2.5 ac), respectively) all other densities were similar across years based on overlapping confidence intervals. The estimated prairie dog populations ranged between 17 and 802 individuals, with an annual average of 291.3 individuals. During the last 5 years of monitoring the estimated average annual population size was 527.6 individuals. Based on the lack of overlapping confidence intervals, the prairie dog population increased significantly every 3 to 4 years. Colony size ranged between 1.4 and 37.7 ha (3.5 and 93.2 ac) during our 11 years of monitoring, with an average annual colony size of 13.0 ha (32.1 ac). During the last 5 years of monitoring the average annual colony size increased by 8.5 ha (20.9 ac). Sylvatic plague was not observed in the black-tailed prairie dog colony at Scotts Bluff National Monument between 1995 and 2005, which was important to the stabilization and increase of the colony's population. Our monitoring demonstrates that a viable black-tailed prairie dog population can establish from a few vagrant individuals and that recovery from a near 100% die-off is possible.

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Key words: colony, *Cynomys ludovicianus,* density, keystone species, mapping, monitoring, Nebraska, population, sylvatic plague, *Yersinia pestis*

The black-tailed prairie dog (*Cynomys ludovicianus*) historically occupied over 404,700 ha (100 million ac) of short- and mixed-grass prairie in 11 western states (National Wildlife Federation 2000a). Currently, less than 2% of this area is occupied. The dramatic decline in black-tailed prairie dog habitat and abundance is the result of changing land use patterns, habitat fragmentation, disease, shooting and poisoning (United States Fish and Wildlife Service 2000). Sylvatic plague (*Yersinia pestis*), introduced from Europe and first identified in prairie dog populations in the mid-1930's (Hubbard 1947), is capable of causing massive die-offs in a population (Barnes 1993, Cully 1993). Also, the required eradication of the species on both private and public lands at the expense of the landowner was the norm in most states (Desmond et al. 2000). This requirement for eradication of black-tailed prairie dog was relaxed in some states when, in

2000 the United States Fish and Wildlife Services ruled the species warranted listing as threatened under the Endangered Species Act (US Fish and Wildlife Service 2000). Black-tailed prairie dog has since been removed as a candidate for protection under the Endangered Species Act (U.S. Fish and Wildlife Service 2004) and widespread control of prairie dogs through shooting and poisoning continues. However, during the 4.5 years that the black-tailed prairie dog warranted listing as a threatened species, considerable effort and resources were invested by federal, state and tribal agencies, private landowners and conservation organizations to better understand the status of the species and design and implement conservation strategies to reduce threats to the species.

Species dependent on the black-tailed prairie dog for food or habitat include the burrowing owl (*Athene cunicularia*), mountain plover (*Charadrius montana*), swift fox (*Vulpes velox*) and ferruginous hawk (*Buteo regalis*) (National Wildlife Federation 2000b, Aschwanden 2001). These species are candidates or potential candidates for listing as threatened under the Endangered Species Act. Once believed to be the most endangered mammal in North America, the black-footed ferret (*Mustela nigripes*), is completely dependent on the prairie dog for its survival (National Wildlife Federation 2000b, Aschwanden 2001).

Initially, concerns for the recovery of the black-footed ferret to stable numbers prompted state and federal agencies, including the National Park Service, to identify lands within the historic range of the black-tailed prairie dog that still host prairie dog populations and to monitor these populations as potential reintroduction sites for the ferret. Eight of the 30 national parks or monuments within the historic range of the black-tailed prairie dog still have active colonies (Badland's National Park, SD; Bent's Old Fort National Historic Site, CO; Devil's Tower National Monument, WY; Fort Larned National Historic Site, KS; Sand Creek Massacre National Historic Site, CO; Scotts Bluff National Monument, NE; Theodore Roosevelt National Park, ND; and Wind Cave National Park, SD). Later concern for the recovery of the black-tailed prairie dog itself has given an even greater impetuous to monitoring their populations.

Black-tailed prairie dog monitoring at Scotts Bluff National Monument, Nebraska, centers on a colony established from vagrant individuals in 1981. Prairie dogs had been absent from the monument since 1944. Colony size, population densities and estimates of overall abundance of prairie dogs on the monument from 1981-1994 are given in Table 1. The rapid and sustained decline in prairie dog numbers between 1988 and 1995 could be the result of several factors including illegal shooting or poisoning, poor winter survival, predation, or sylvatic plague (Knowles 1998).

For the period 1995-1999, black-tailed prairie dog populations on the monument were monitored through a joint effort of the Heartland Network Inventory and Monitoring Program, formerly the Prairie Cluster Prototype Long-Term Ecological Monitoring Program and the Northern Prairie Wildlife Research Center, Biological Resources Division of the United States Geological Survey. A peer-reviewed monitoring protocol was the result of this endeavor (Plumb et al. 2001). Monument personnel and Heartland Network Inventory and Monitoring Program staff continue annual prairie dog monitoring.

The objectives of black-tailed prairie dog monitoring at Scotts Bluff National Monument are to estimate abundance of prairie dogs annually; map annual size and location of the prairie dog colony; and determine through observation if sylvatic plague (*Yersinia pestis*) is present in the prairie dog population.

STUDY AREA

We monitored black-tailed prairie dog populations on a colony located at Scotts Bluff National Monument. Scotts Bluff National Monument is a 1214.0-ha (3000-ac) National Park Service unit in the western panhandle of Nebraska bordering the south bank of the North Platte River, Scotts Bluff County. Vegetation of the area is mixed grass prairie. Much of the monument area is high sandy rock bluffs and outcroppings or deep sharply-cut ravines. However, 698.0 ha (1724.8 ac) of the monument is level grassland habitat.

Table 1. Annual colony size, population density and numbers of black-tailed prairie dogs (*Cynomys ludovicianus*) at Scotts Bluff National Monument, Nebraska, between the colony reestablishment in 1981 and 1994. Sources of annual data are indicated.

Year	Area (ha)	Density (individuals/ha)	Population Size	Source
1981	Colony Reestablishment in Scott's Bluff National Monument			
1982	--	--	--	None
1983	1.0	76.5	75.0	Franklin 1984
1984	1.3	30.5	40.0	Franklin 1984
1985	--	--	107.0	Cox and Franklin 1989
1986	5.8	34.7	200.0	Cox and Franklin 1989
1987	5.1	58.9	303.0	Cox and Franklin 1989
1988	3.4	64.6	219.0	Cox and Franklin 1989
1989	--	--	62.0	Monument Personnel unpub.
1990	--	--	62.0	Monument Personnel unpub.
1991	--	--	27.0	Monument Personnel unpub.
1992	--	--	--	None
1993	--	--	45.0	Monument Personnel unpub.
1994	--	--	--	None

METHODS

Prairie Dog Density and Abundance

We monitored black-tailed prairie dog populations on a colony at Scotts Bluff National Monument, Nebraska between 1995 and 2005. Plumb et al. (2001) detailed the monitoring methods used to estimate black-tailed prairie dog densities, abundance and colony sizes. Since 2001, 2 observers on elevated stands have counted prairie dog numbers on the monument. Prior to this date, 1 observer on an elevated stand could see the entire colony, thus effectively conduct counts. Eight replicate counts, with 15-min intervals between the start of each replicate were made from each stand. Counts were conducted annually on 3 consecutive days from mid-July to early August, weather permitting. As a result of colony expansion, part of the colony was obscured from observers in 2005, the last year of monitoring. The acreage, 9.7 ha (24.0 ac), obscured from view was removed from total colony acreage prior to estimating density. In years when 2 observers counted prairie dogs, they did so simultaneously. To minimize counting individuals twice during a replicate, landscape features and pin flags were utilized to section up the colony and define areas for each person to observe. Daily replicate counts from each stand were combined in order to calculate estimates of population density and size. Counts commenced 1 hr after official sunrise on mornings with little or no precipitation. In years when 2 observers counted prairie dogs, counts from each stand were combined to produce a colony-wide estimate. Using the visual count data, 2 calculations were made to estimate annual black-tailed prairie dog density and abundance within the colony. Estimated density (P) is derived from the linear relationship described by Severson and Plumb (1998): Density (P) = [((Y/Sp) – 3.04)/0.40], where Y is the maximum count of individuals in a replicate over the 3-day survey period and Sp is the total area sampled. Density was calculated from the maximum count of individuals in a replicate and colony size, adjusted for the probability of not observing all individuals during the count. The adjustment coefficient is based on mark-recapture data (Severson and Plumb 1998). The maximum count (out of 24) was used because it is significantly correlated with prairie dog abundance as determined by mark-recapture data.

Abundance (T) = (Sc)(P), where Sc is the total colony size (in ha) and P the estimated density/ha.

A 95% confidence interval was calculated for density and abundance using the following formulas:

$$\text{Density lower limit, } P = P - 1.96\,[SE(P)]$$

Density upper limit, P = P + 1.96 [SE(P)]

Abundance lower limit, T = T – 1.96 [SE(T)]

Abundance upper limit, T = T + 1.96 [SE (T)]

where SE is the standard error for Density (P) and Abundance (T), respectively. Standard error (SE) is derived by calculating variance, (P) = 66 + 0.025 $(P - 18.4)^2$ or (T) = 66 + 0.025 $(T - 18.4)^2$ for Density (P) and Abundance (T), respectively, and then SE (P or T) = Variance (P or T) (Plumb et. al. 2001). Means with overlapping confidence intervals are not significantly different.

To help explain annual variations in the black-tailed prairie dog populations, precipitation data was obtained from the National Weather Service, station 257665 at Scotts Bluff, Nebraska, regional airport. Precipitation influences the amount of forage produced, which in turn influences the amount of area required by black-tailed prairie dogs for foraging. Larger foraging areas are required in dry years compared to wet years.

Colony Mapping

Annual boundaries of the black-tailed prairie dog colony at Scotts Bluff National Monument were delineated using a Global Positioning System in conjunction with a PC-based Geographic Information System, ArcGIS v.9™. Colony boundaries were determined as the area within 5 m (16.4 ft) of active burrows on the perimeter of the colony. Active clip lines were indistinguishable most years, therefore not mapped. Burrows were classified as active if burrow openings were greater than 7.0 cm (2.8 in) in diameter and fresh scat was observed within 0.5 m (1.6 ft) of the opening. Burrows were classified inactive if there were spider webs across an opening or unclipped vegetation growing in or around the opening

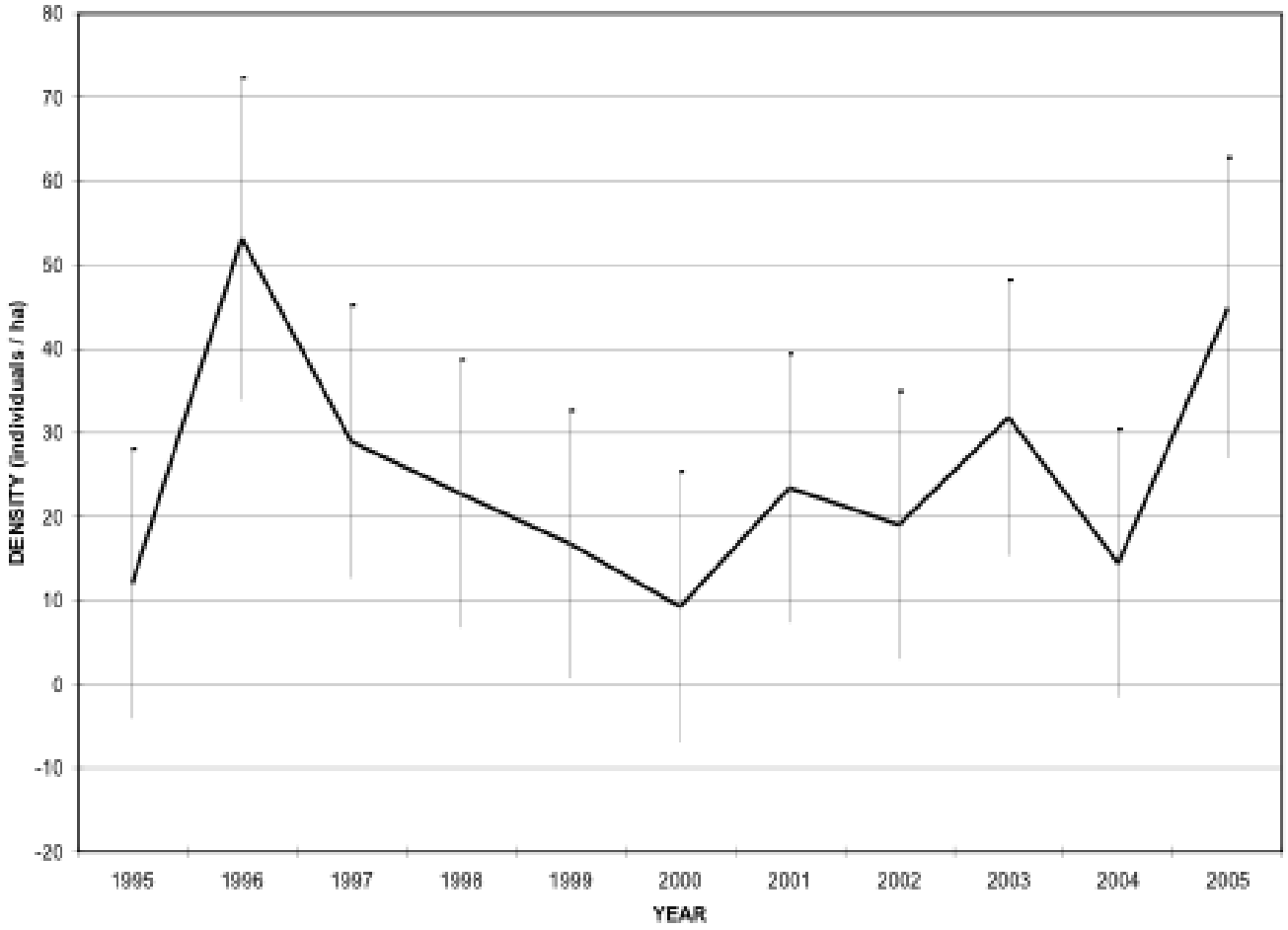

Fig. 1. Annual estimates of black-tailed prairie dog densities (*Cynomys ludovicianus*) at Scotts Bluff National Monument, Nebraska for years 1995 to 2005. Bars at each annual density estimate represent a calculated confidence interval for that year. It is assumed that years with widely overlapping confidence intervals are not significantly different.

(Biggins et. al. 1993, Desmond et. al. 2000). Colored pin flags were used to mark the perimeter of the colony prior to GPS mapping. Boundaries were walked in their entirety in order to close each colony polygon.

Sylvatic Plague Surveillance

The Monument personnel monitored for sylvatic plague presence within the black-tailed prairie dog colony throughout the year. A substantial die-off in the population would alert monument personnel to a potential sylvatic plague outbreak. If a sylvatic plague outbreak was suspected, then the appropriate authorities would have been notified to verify the presence or absence of sylvatic plague.

RESULTS

Prairie Dog Abundance and Density

We determined the density and abundance of black-tailed prairie dogs on a colony at Scotts Bluff National Monument using 202 counts over 11 years. Annually, we averaged 18.4 counts over 3 days in July or August. Our estimated density of prairie dogs ranged between 9.2 individuals/ha (3.7 individuals/ac) in 2000 and 53.0 individuals/ha (21.5 individuals/ac) in 1996 (Fig. 1). Black-tailed prairie dog densities varied by a factor of 5.8 between the minimum and maximum estimates. However, estimated densities for all years were similar based on overlapping confidence intervals with the exception of the 1996 density and the 2005 density of 44.9 individuals/ha (18.2 individuals/ac). For the 11-year period of monitoring, prairie dogs averaged 25.1 individuals/ha (10.2 individuals/ac) annually.

The estimated black-tailed prairie dog population sizes ranged between 17.0 and 802.0 individuals, with an annual average of 291.3 individuals (Fig. 2). The 1995 population was estimated at 17.0 individuals. However, the population increased to 74.0 individuals by 1996.

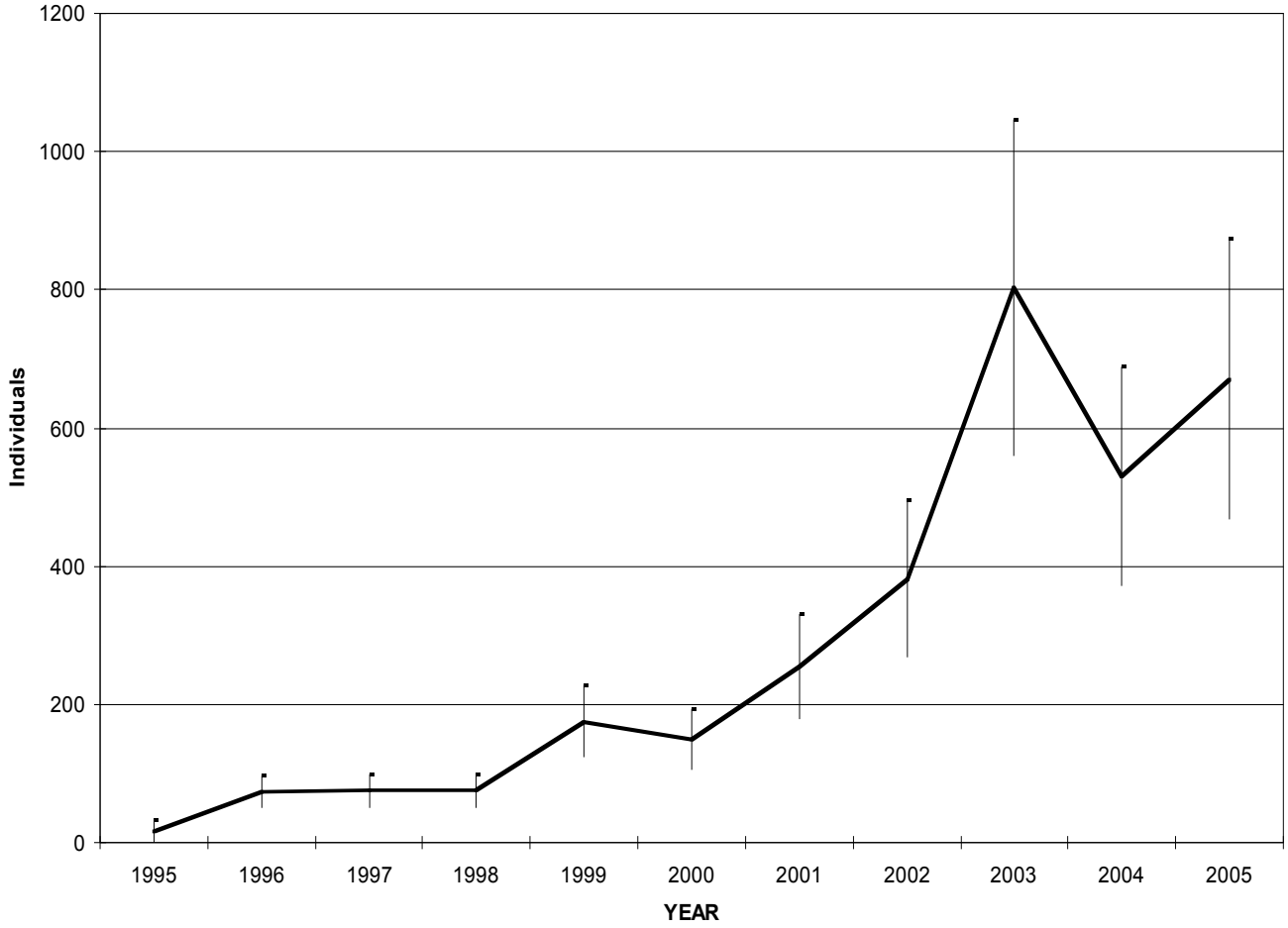

Fig. 2. Annual estimates of black-tailed prairie dog (*Cynomys ludovicianus*) population sizes at Scotts Bluff National Monument, Nebraska for years 1995 to 2005. Bars at each annual population estimate represent a calculated confidence interval for that year. It is assumed that years with widely overlapping confidence intervals are not significantly different.

By 1999 the population was estimated at 175.0 individuals and has only dropped below this number once since then: 2000. During the last 5 years of monitoring, the average annual population size was estimated at 527.6 individuals. Based on overlapping confidence intervals, the prairie dog population has increased significantly every 3 to 4 years since monitoring began.

Colony Mapping

Maps depicting changes in the location and extent of the black-tailed prairie dog colony at Scotts Bluff National Monument between 1995 and 2005 are shown in Fig. 3. Colony size ranged between 1.4 and 37.7 ha (3.5 and 93.2 ac) during our monitoring. Average annual colony size was 13.0 ha (32.1 ac) for the years of monitoring. During the last 5 years, average annual colony size was 21.5 ha (53.2 ac).

The location and shape of the black-tailed prairie dog colony has remained somewhat similar over the years (Fig. 3). However, the perimeter of the colony expanded outward in all years but 2001 and 2005. In 2001 and 2005, the prairie dog population abandoned large areas of the colony and retreated to small "islands" as opposed to inhabiting one continuous area.

Sylvatic Plague Surveillance

Sylvatic plague was not observed in the black-tailed prairie dog colony at Scotts Bluff National Monument between 1995 and 2005.

DISCUSSION

Black-tailed prairie dogs at Scotts Bluff National Monument, Nebraska have formed a viable population from a few vagrant individuals. The annual prairie dog density of 25.1 individuals/ha (10.2 individuals/ac) observed on the colony is very much in line with densities reported by Hoogland (1995) for colonies elsewhere. Similar densities across studies suggest that black-tailed prairie dog populations may have an optimum density for colony survival. An optimum density maximizes predator defenses while minimizing the effects of colonial crowding on resources such as

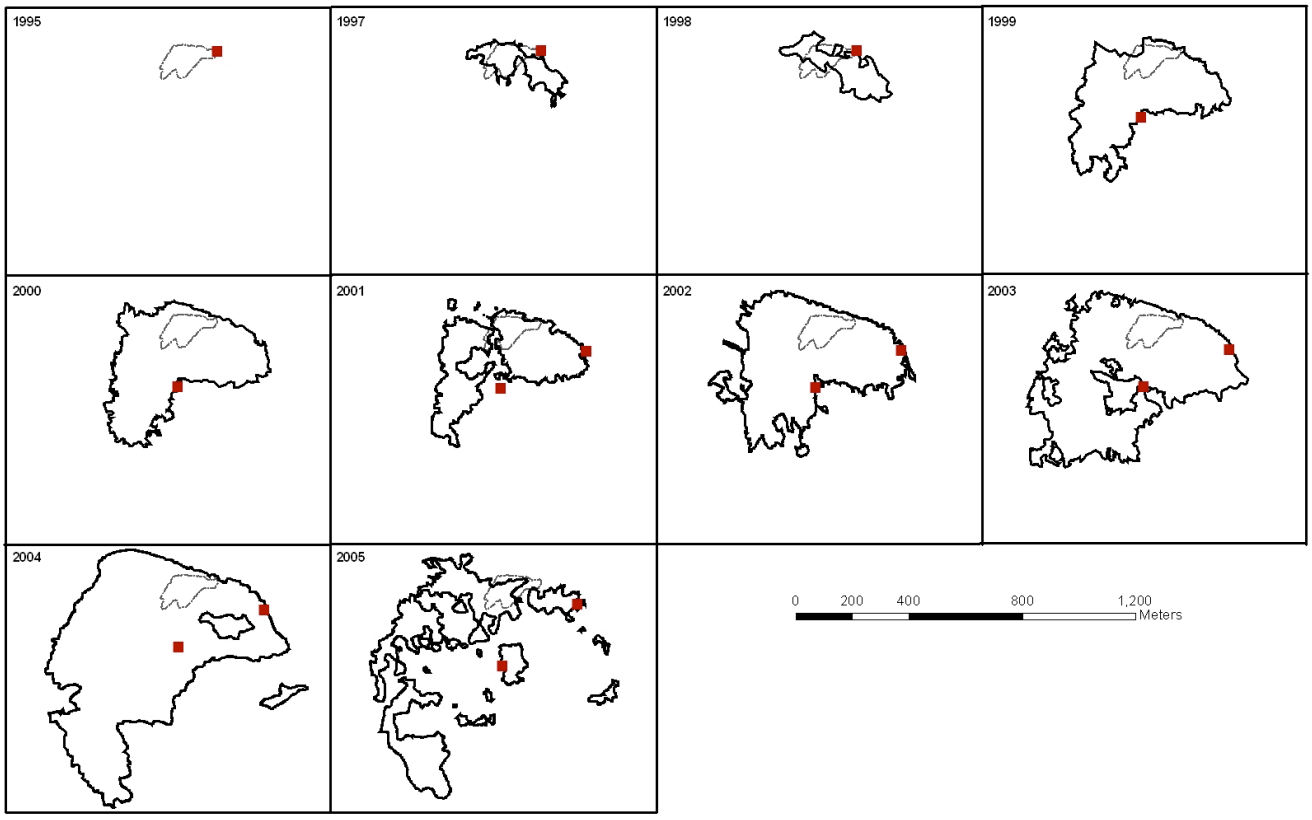

Fig. 3. Black-tailed prairie dog (*Cynomys ludovicianus*) colony sizes and shapes at Scotts Bluff National Monument, Nebraska for years 1995 to 2005, with the exception of 1996. However, the colony size and shape was roughly the same for 1995 and 1996. The colony boundary for 1995 is shown on all years as a reference. Squares symbolize the location of monitoring stands.

food and burrow sites. Infanticide, a common yet unexplained practice seen in the black-tailed prairie dog (Hoogland 1995) may serve to keep densities at an optimum level.

Our findings suggest that black-tailed prairie dog densities were influenced by precipitation and the resulting vegetation growth, as well. When precipitation was sufficient to positively influence vegetative growth, such as in 2005, a year with above average precipitation in May and June, prairie dogs foraged in areas closer to their burrows (Fig. 4). Therefore, densities increased and less area was required to maintain the colony. In fact, in 2001 (another year of good growing season precipitation) and 2005 the prairie dog populations abandoned large areas of the colony and retreated to small "islands" as opposed to inhabiting one continuous area. In years of less growing season precipitation such as in 2000, 2002 and 2004, prairie dogs foraged further from their burrows to secure an adequate food source. Thus increasing the size of area the colony occupied.

The black-tailed prairie dog colony at Scotts Bluff National Monument demonstrated an r-selection survival strategy. In the 9-year period between 1995 and 2003 the population grew 47.2 times its original size of 17 individuals. The number of individuals on the colony has declined only slightly since 2003. The importance of the prairie dogs rapid population growth strategy could be realized if one desires to establish new colonies to aid in recovering the species numbers, the black-footed ferret or other associate species. Our monitoring also suggests that black-tailed prairie dog populations can recover to viable numbers, even after experiencing a near 100% population die-off (Fig. 1). A die-off potentially caused by sylvatic plague.

Presently, the colony at Scotts Bluff National Monument occupies only a small portion of the monument (i.e. 2.1% of the 698-ha [1725-ac] of grassland). However, dispersal from the colony may lead to new colony establishments much in the way the current colony began. Dispersal usually

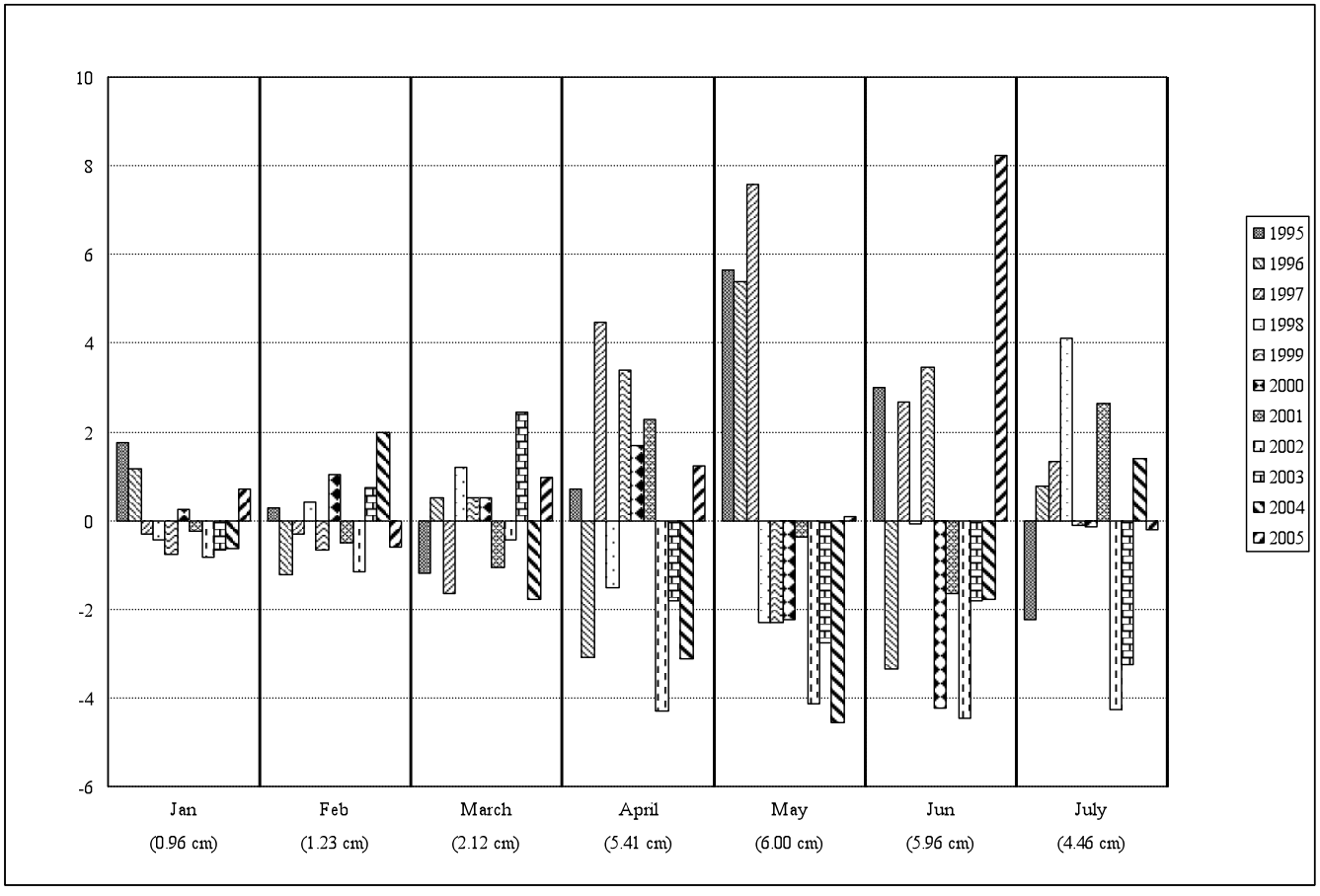

Fig. 4. Deviations from average monthly precipitations, in centimeters, at Scotts Bluff National Monument, Nebraska. Deviations from monthly averages are given for the first seven months of each year. Average monthly precipitation, calculated for years 1995 through 2005 are listed below their respective month.

begins in late winter and is complete by the end of June (Garrett and Franklin 1988, Hoogland 1995). By mapping the colony location and size annually, monument staff has had the opportunity to assess the impacts of colony expansion on the cultural and natural resources of the monument. To date, the colony has not expanded into areas of the monument that are culturally significant. Areas such as the Oregon Trail ruts, which passes through the monument.

Sylvatic plague surveillance as well as surveillance for other mortality factors is an integral component of our black-tailed prairie dog monitoring at Scotts Bluff National Monument. During the 11 years of monitoring there has been no evidence of a sylvatic plague outbreak or any other mortality factors influencing the colony. However, if a rapid decline in the prairie dog population were to have been observed, it would have been investigated to minimize the chance of human exposure to the plague. A rapid decline in the population would also be investigated for any illegal activities such as poisoning and shooting that may be occurring.

MANAGEMENT IMPLICATIONS

The black-tailed prairie dog can be recovered to viable populations from a few vagrant individuals moving into an area. The importance of this could be realized if one desires to establish new colonies to aid in recovering black-footed ferret numbers and the numbers of other species in peril. Our monitoring also suggests that black-tailed prairie dog populations can recover, even after experiencing a near 100% die-off.

Another finding from our monitoring is that precipitation may influence the amount of area our black-tailed prairie dog colony occupied. During wet years, black-tailed prairie dogs forage closer to their burrows and occupy less area than in drier years. Therefore, colonies with similar population sizes can occupy areas of various sizes. This needs to be considered when assessing the status of a black-tailed prairie dog population based on the area their colony occupies.

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APPENDIX: Illustrations

Appendix Fig. 1. A black-tailed prairie dog (*Cynomys ludovicianus*) in a burrow entrances at Scotts Bluff National Monument, Nebraska.

APPENDIX (Continued)

Appendix Fig. 2. Black-tailed prairie dog (*Cynomys ludovicianus*) burrows on a colony at Scotts Bluff National Monument, Nebraska.

Appendix Fig. 3. A researcher conducting black-tailed prairie dog (*Cynomys ludovicianus*) surveys at Scotts Bluff National Monument, Nebraska.